Algorithms

The Telecom Economic Cost Model is an "open" model that allows you to review and study all assumptions and algorithms used in developing the cost estimates. The algorithms have been logically grouped into sections you can access by selecting the appropriate button on the *Algorithms* page, which functions like a table of contents. You can jump to the *Algorithms* page by pushing the button labeled, "Algorithms" at the top of various pages of the model, including the *Financial, and Technical* pages. From the *Algorithms* page, you can move directly to the algorithms used by the model in developing the cost estimates. To move to a different group of algorithms, return to the *Algorithms* page, then jump to the desired section.

Customer Premises Termination Costs

This section of the model estimates the cost of facilities at or adjacent to the customer's premises. These are the network interface device (NID) which separates the drop wire/building cable from the customer's inside wiring and premises equipment (telephone set or phone system); the drop wire and/or building cable running between the NID and the

network terminal, and the network terminal where the drop wire/building cable is connected to the distribution cable.

The model determines the appropriate investment amounts using the inputs on the *Financial* and *Technical* pages. Annual cost factors are then applied to the total investments, which are converted to annual and monthly costs. The algorithms are found on the *Termination* page, which is accessed by pressing the "Go To Customer Premises Termination Algorithms" button.

Switching and Trunking Costs

This section estimates costs of the end office switching equipment located at the wire center. It also estimates the cost of tandem switching and interoffice trunking that is associated with the wire center. It develops the latter estimates on a simplified basis, thereby providing an estimate of the cost of the interoffice trunks leaving the wire center, and a fractional share of the tandem switching equipment used in routing some calls to and from the wire center. However, it does not model in detail the interoffice trunking network and tandem switching investment for the entire exchange or LATA.

The inputs on the *Technical* and *Financial* pages are used by the model to develop the investment in end office switching, tandem switching, and interoffice trunking. Cost factors are then used to convert these amounts to annual and monthly costs. These calculations are found on the page *SwitchTrunk*, which you access by pressing the button labeled, "Go To Switching and Trunking Algorithms."

Billing and Collection Costs

This section compiles an estimate of the cost of billing and collection for typical retail customers, segregated into joint and direct cost items.

Joint billing and collection costs include preparing and handling a bill of minimum size, the envelope, and the minimum amount of postage. Direct billing and collection costs (attributable to individual services) include all other costs. These include the data processing required to compute the billing amount for each service, the additional costs associated with rendering bills of greater than minimum length, centralized mail remittance, customer service, and bill inquiry.

These costs are determined by the user-selected inputs on the *Financial* inputs page, stated on a per loop per month basis and then computed for various combinations of lines per retail customer. These calculations are found on the page *BillColl*, which you access by pressing the button labeled, "Go To Billing and Collection Algorithms."

Wire Center Data

The button labeled "Go to Wire Center Data" will take you to the *WireCenters* page. This section contains detailed information about the underlying characteristics of each wire center's serving area. In it, data concerning the number of households, the number of business loops, and loop lengths are imported into the model for each geographic quadrant of each wire center. The household data are converted into an estimate of the total number of residence loops, using a multiplier which you input on the *Technical* page.

You may adjust or modify wire center data in developing a particular study. For example, the market share percentages

you select will control the actual number of loops included in the network being modeled. To compare the underlying wire center data with summary characteristics of the network as modeled, push the button labeled "Wire Center Characteristics" at the top of the screen. This takes you to the *Wire Center Characteristics* page, where descriptive data from the model is displayed.

Network Characteristics

The button labeled, "Go to Network Characteristics Algorithms" will take you to the *NetChar* page. This section takes your assumptions and builds a telecom network (or two networks, in the case of a TSLRIC study) that matches your specifications. The user inputs, such as the study type, customer type, cable technology and market share, all influence the optimum design of the network(s). Given the underlying characteristics of the area served by the wire center, and the user specified inputs, the model determines the number of loops in each segment and the loop lengths of each segment.

Using a simplified approach, the model sizes the facilities for each geographic quadrant and for each zone within each quadrant. For simplicity, the model assumes that the area served by each quadrant is square, with the wire center at the exact center of up to four quadrants. However, the quadrants need not be of identical size. The model also assumes that the area designated as "zone one" is one quarter of each quadrant, and is located adjacent to the wire center. The area designated as "zone two" contains the remaining three quarters of each quadrant and surrounds zone one.

Consistent with typical industry practice, the cable connecting the wire center with the individual end-user premises is

modeled as a tapering tree/branches configuration, with the sheath size of the branches diminishing (and the number of branches expanding) as one moves away from the wire center and toward the customers. The model selects the minimum cable size to accommodate the number of loops served by each cable without exceeding the specified utilization factor. When this is accomplished, the model often "rounds up," which provides additional spare capacity beyond the minimum mandated by the utilization factor.

Segment A contains feeder cable leaving the wire center. The B Segment connects with segment A, and serve zone 1. The C segments connect with the B segments, and provide the final leg of distribution cable to customers in zone 1. Segment D is connected to Segment A, and contains feeder cable serving zone 2. The E Segments connect with segment D, and serves zone 2. The F segments connect with the E segments, and provide the final leg of distribution cable to customers located in zone 1.

Loop Cost

The Loop Cost section accumulates most of the cost calculations related to the loop portion of the model. In this section the investments associated with the network(s) defined in the "Network Characteristics" section are calculated by quadrant and by zone. Annual cost factors are applied to convert these investments into annual and monthly cost estimates for zone 1, zone 2, and the network as a whole. You can reach the *LoopCost* page, by pressing the "Go to Feeder and Distribution Algorithms" button.

Copper Cost

The Copper Cost section develops the investment in copper cable, including the loaded material costs of the various cable

segments and the cost of engineering, placement and splicing. These investment amounts are controlled by your inputs on the *Financial* and *Technical* pages. You reach the *CopperCost* page by pushing the "Go to Copper Cost Algorithms" button.

Fiber Cost

The Fiber Cost section develops the investment in fiber cable and electronics, including the loaded material costs of the various cable segments and the cost of engineering, placement, and splicing. These investment amounts are controlled by your inputs on the *Financial* and *Technical* pages. This page is directly analogous to the *CopperCost* part of the model; it is used only if your study includes fiber optic technology. The *FiberCost* page is reached by pushing the "Go to Fiber Cost Algorithms" button.

Structures Cost

This section estimates the investment in poles, conduit, and trenching. The page *StructCost* is reached by selecting the "Go to Outside Plant Structures Algorithms" button.

Miscellaneous Data

This page includes certain miscellaneous data and calculations used by the model. The *MiscData* page is reached by selecting the "Go to Miscellaneous Data" button.

Annual Cost Factors

This section calculates the annual cost factors used in converting the investment amounts into annual (and thence monthly) costs. A levelizing process spreads the investment over the entire economic life of the item. The calculations rely upon debt/equity ratios, capital cost rates and income tax rates input by the user on the *Financial* inputs page.

You can access the *AnnCost* page by pushing the "Go to Annual Cost Factors" button. Additional algorithms used in developing

the annual cost factors are contained in a series of pages associated with different economic lives (in five-year increments). Access these additional calculations by pressing the appropriate buttons at the top of the *AnnCost* page: "AnnCost 5," "AnnCost 10," ... "AnnCost 50."

Ben Johnson Associates, Inc.
Telecom Economic Cost Model

Control

Estimate: LRAC-Long Run Average Cost

Identify the type of service to be studied and set key assumptions, then examine the results.

Establish Parameters and View Results

○ Study a hypothetical wire center with typical characteristics.

Average
Rural Area
Small Town

◉ Study a wire center by company in the database. Select the CLLI code.

Company	Wire Center
Southwestern Bell (Texas)	ABLNTXORR
	ABLNTXOWH
	ABRYTXGIS

Wire Center Location: ABILENE

○ Study a hypothetical wire center with characteristics established by the user.

Establish characteristics

Establish or modify key input values and assumptions.

Financial Assumptions | Technical Assumptions

Control | LRAC Results | Financial Assumptions | Technical Assumptions | Wire Center Characteristics | Algorithms

Use these buttons to jump to other parts of the model

Total Service Long Run Average Cost

Study Type:

Analyze [single & multi line] [residence and business] customers on a composite basis, considering [direct, joint and common costs.]

Joint Costs

Select the percentage allocation factor.

80%
90%
100%

Common Costs

Select the allowance for common costs (as a percent of direct/joint costs)

8%
9%
10%

Size of carrier:

% share of total lines

	Residence	Business
Zone 1 (closer to wire center)	100%	100%
Zone 2 (farther from wire center)	100%	100%

ABLNTXORR
CLLI code for Wire Center

Total Cost per Line		**16.26**
Local Exchange		
Switching & Trunking	$	2.11
Billing and Collection	$	0.29
Total Local Costs	**$**	**2.40**
Joint		
End Office	$	2.33
Loop	$	7.18
Termination	$	2.71
Billing and Collection	$	0.17
Total Joint Costs	**$**	**12.38**
Subtotal	$	14.78
Common Costs	**$**	**1.48**

View Detailed Cost Results

Control | TSLRIC Results | Financial Assumptions | Technical Assumptions | Wire Center Characteristics | Algorithms

Use these buttons to jump to other parts of the model

Total Service Long Run Incremental Cost

Study Type:

Add ▼ an increment of single & multi line ▼ business ▼ service

to a network serving single & multi line ▼ residence ▼

customer locations considering direct, joint and common costs. ▼

Joint Cost Allocation

Select the percentage allocation factor for joint costs.

80%
90%
100%

Common Cost Allocation

Select the allowance for common costs (as a percent of direct/joint costs)

8%
9%
10%

Size of carrier including incremental volume:

% share of total lines

	Residence	Business
Zone 1 (closer to wire center)	100%	
Zone 2 (farther from wire center)	100%	

Size of increment:

% of total lines to add to	Residence	Business
Zone 1 (closer to wire center)		100%
Zone 2 (farther from wire center)		100%

Size of carrier excluding incremental volume:

% share of total lines	Residence	Business
Zone 1 (closer to wire center)	100%	0%
Zone 2 (farther from wire center)	100%	0%

ABLNTXORR
CLLI Code for Wire Center

Total Cost per Line	**15.05**
Local Exchange	
Switching & Trunking	3.67
Billing and Collection	0.28
Total Local Costs	**3.95**
Joint	
End Office	2.06
Loop	5.30
Termination	2.33
Billing and Collection	0.04
Total Joint Costs	**9.73**
Subtotal	13.69
Common Costs	**1.37**

View Detailed Cost Results

Control | TELRIC Results | Financial Assumptions | Technical Assumptions | Wire Center Characteristics | Algorithms

Use these buttons to jump to other parts of the model

Total Element Long Run Incremental Cost

Study Type:

Analyze the incremental cost of adding loops including CPT, except NID

to a network containing all other elements necessary to provide bundled services, considering direct and common costs.

Common Cost Allocation

Select the allowance for common costs (as a percent of direct costs)

9%
10%
11%

Size of carrier

% share of total lines

	Residence	Business
Zone 1 (closer to wire center)	100%	100%
Zone 2 (farther from wire center)	100%	100%

ABLNTXORR
CLLI Code for Wire Center

Total Cost per line	**10.26**
Loop	7.18
Termination w/out NID	2.15
Subtotal	9.33
Common Costs	**0.93**

Control | LRMC Results | Financial Assumptions | Technical Assumptions | Wire Center Characteristics | Algorithms

Use these buttons to jump to other parts of the model

Marginal Cost of a Service

Study Type:

On a network serving [single & multi line] [residence and business]

locations, estimate the marginal cost of [single & multi line] [residence and business]

stated on a per line basis, considering [direct, joint and common costs.]

Joint Cost Allocation

Select the percentage allocation factor for joint costs.

80%
90%
100%

Common Cost Allocation

Select the allowance for common costs (as a percent of direct/joint costs)

10%
11%
12%

Size of carrier:

% share of total lines (specifies volume of output)

	Residence	Business
Zone 1 (closer to wire center)	100%	100%
Zone 2 (farther from wire center)	100%	100%

Smoothing

Estimate marginal cost as the slope of the total cost curve within a range of plus or minus of the previously specified volume of output.

7.5%
10.0%
12.5%

ABLNTXORR
CLLI Code for Wire Center

Total Cost per Line	**14.59**
Local Exchange	
Switching & Trunking	2.11
Billing and Collection	0.29
Total Local Costs	**2.40**
Joint	
End Office	2.01
Loop	5.98
Termination	2.71
Billing and Collection	0.17
Total Joint Costs	**10.87**
Subtotal	13.27
Common Costs	**1.33**

View Graph of Total Cost Curve

Control | LRMCE Results | Financial Assumptions | Technical Assumptions | Wire Center Characteristics | Algorithms

Use these buttons to jump to other parts of the model

Marginal Cost of an Element

Study Type:

Analyze the marginal cost of adding loops including CPT, except NID

to a network containing all other elements necessary to provide bundled services, considering direct and common costs.

Common Cost Allocation

Select the allowance for common costs (as a percent of direct/joint costs)

10%
11%
12%

Size of carrier:

% share of total lines (specifies volume of output)

	Residence	Business
Zone 1 (closer to wire center)	100%	100%
Zone 2 (farther from wire center)	100%	100%

Smoothing

Estimate marginal cost as the slope of the total cost curve within a range of plus or minus of the previously specified volume of output.

2.5%
5.0%
7.5%

ABLNTXORR
CLLI Code for Wire Center

Total cost per line	**8.43**
Loop	5.98
Termination w/out NID	
Drop Wire/Bdng. Cable	1.68
Terminal	0.47
Subtotal	7.66
Common Costs	**0.77**

Control | Results | Technical Assumptions | Algorithms

Use these buttons to jump to other parts of the model

Financial Assumptions

Annual Cost Factors

Federal Income Tax Rate	35.00%
State Income Tax Rate	0.00%
Debt % of Total Capitalization	40.00%
Equity % of Total Capitalization	60.00%
Cost of Debt	8.50%
Cost of Equity	12.00%

	Average Life	Plant Specific Charge
Remote Electronics	12.0	5.00%
Poles	30.0	4.00%
Aerial Copper Cable	15.0	10.00%
Underground Copper Cable	15.0	7.50%
Buried Copper Cable	15.0	10.00%
Aerial Fiber Cable	20.0	10.00%
Underground Fiber Cable	25.0	7.50%
Buried Fiber Cable	25.0	10.00%
Conduit Systems	50.0	2.50%
Switching/End Office	12.0	6.00%
Trunking	15.0	7.50%
Termination	15.0	8.00%

Loaded Labor Cost per Hour

$60.00	Engineer
$40.00	Tech II
$40.00	Tech I

Additional loading for special equipment

Pole installation	$15.00
Trenching	$15.00
Trenching (Man-made obstacles)	$20.00
Manhole installation	$15.00

Interoffice Trunking

Electronics investment per 64 bit channel (EF&I)

DS1

DS1	$ 240
DS3	$ 180

	Local	Switched Access
Other Investment per channel (EF&I)	$ 75	$ 150

Loop Fiber Electronics

Material Cost

	Wire Center	Remote
Minimum (per location)	$ 15,000	$ 15,000

Per 64 bit channel

From	To			
1	24	channels	$ 200.00	$ 250.00
25	120	channels	$ 150.00	$ 200.00
121	672	channels	$ 125.00	$ 150.00
673	or more	channels	$ 100.00	$ 125.00

Billing and Collecting

	Residence	Business
Joint Cost per month		
Bill Handling, Envelope, Minimum Postage	$ 0.32	$ 0.32
Direct Cost per month		
Centralized Mail Remittance	$ 0.05	$ 0.05
Customer Service	$ 0.06	$ 0.04
Bill Inquiry	$ 0.10	$ 0.10
Data Processing	$ 0.09	$ 0.09

Outside Plant Structures

	Material Cost
Aerial (per Pole)	$ 200
Underground manholes	
Fixed (per hand/manhole)	$ 2,000
Variable (per cable pair per hand/manhole)	$ 1.00
Underground conduit	
Fixed (per foot)	$ 3.00
Variable (per cable pair per foot)	$ 0.0030
Sod (installed per linear foot)	$ 0.80

Switching Investment

	EF & I Investment	Building & Other Misc. Investment
Minimum Size Configuration:	$ 30,000	$ 7,500

Non Traffic Sensitive Switching Investment

Switch Size (Lines) From	To	EF & I Investment	Building & Other Misc. Investment
1	399	$ 200.00	$ 20
400	999	$ 175.00	$ 20
1,000	1,999	$ 150.00	$ 20
2,000	2,999	$ 135.00	$ 20
3,000	4,999	$ 125.00	$ 20
5,000	9,999	$ 115.00	$ 20
10,000	19,999	$ 105.00	$ 20
20,000	29,999	$ 95.00	$ 20
30,000	or more	$ 90.00	$ 20

Traffic Sensitive Switching Investment

Call Setup (per hundred calls/day)	$ 200.00
Minutes of Use (per hundred minutes/day)	$ 50.00

Other Switching Features

Per Line per Month	$ 0.30

Feeder and Distribution Investment

Copper Cable

Material Cost per Sheath Foot

Pairs per Sheath	Aerial	Underground	Buried
0	$ -	$ -	$ -
6	$ 0.30	$ 0.35	$ 0.36
12	$ 0.40	$ 0.45	$ 0.46
25	$ 0.60	$ 0.70	$ 0.72
50	$ 0.90	$ 1.05	$ 1.10
100	$ 1.45	$ 1.70	$ 1.75
200	$ 2.50	$ 2.90	$ 3.00
300	$ 3.50	$ 4.00	$ 4.10
400	$ 4.50	$ 5.05	$ 5.20
600	$ 6.50	$ 7.30	$ 7.50
900	$ 9.50	$ 10.50	$ 10.75
1,200	$ 11.50	$ 12.50	$ 12.90
1,500	$ 13.00	$ 14.10	$ 14.55
1,800	$ 14.50	$ 15.70	$ 16.20
2,100	$ 16.00	$ 17.30	$ 17.85
2,400	$ 17.50	$ 18.90	$ 19.50
2,700	$ 19.00	$ 20.50	$ 21.15
3,000	$ 20.50	$ 22.10	$ 22.80
3,600	$ 23.50	$ 25.30	$ 26.10
4,200	$ 26.50	$ 28.50	$ 29.40

Fiber Cable

Material Cost per Sheath Foot

Pairs per Sheath	Aerial	Underground	Buried
0	$ -	$ -	$ -
4	$ 0.30	$ 0.35	$ 0.35
6	$ 0.40	$ 0.45	$ 0.45
8	$ 0.50	$ 0.55	$ 0.55
10	$ 0.60	$ 0.65	$ 0.65
12	$ 0.70	$ 0.80	$ 0.80
18	$ 0.85	$ 1.00	$ 1.00
24	$ 1.05	$ 1.20	$ 1.20
30	$ 1.25	$ 1.40	$ 1.40
36	$ 1.45	$ 1.60	$ 1.60
48	$ 1.85	$ 2.00	$ 2.00
60	$ 2.25	$ 2.40	$ 2.40
72	$ 2.65	$ 2.80	$ 2.80
84	$ 3.05	$ 3.20	$ 3.20
96	$ 3.45	$ 3.60	$ 3.60
108	$ 3.85	$ 4.00	$ 4.00
120	$ 4.25	$ 4.40	$ 4.40
132	$ 4.65	$ 4.80	$ 4.80
144	$ 5.05	$ 5.20	$ 5.20
156	$ 5.45	$ 5.60	$ 5.60
168	$ 5.85	$ 6.00	$ 6.00
180	$ 6.25	$ 6.40	$ 6.40

Other Investment

	Per Loop	Per Wire Center
Building and Main Distributing Frame	$10.00	$2,500
Cross Connects, and other miscellaneous materials.	$10.00	$2,500

Customer Premises Termination

Drop Wire/Building Cable

Pairs per Sheath	Material Cost per Sheath Foot
0	$ -
3	$ 0.30
6	$ 0.35
12	$ 0.45
25	$ 0.70
50	$ 1.05
100	$ 1.70

Remote Terminal

Customer Size (Lines) From	To	EF & I Investment
1	2	$ 35
3	6	$ 100
7	25	$ 400
26	50	$ 600
51	100	$ 1,100

Network Interface Device

Customer Size (Lines) From	To	EF & I Investment
-	-	$ 15
2	2	$ 28
3	3	$ 40
4	25	$ 275
26	50	$ 500
51	100	$ 950

Control | Results | Financial Assumptions | Algorithms

Use these buttons to jump to other parts of the model

Technical

Utilization Factors

	Zone 1	Zone 2
Copper Cable		
Feeder	87.5%	87.5%
Feeder/Distribution	85.0%	85.0%
Distribution	75.0%	75.0%
Fiber Cable		
Feeder	87.5%	87.5%
Feeder/Distribution	85.0%	85.0%
Distribution	75.0%	75.0%
Customer Premises Facilities	90.0%	90.0%
Fiber Electronics	90.0%	90.0%
Switching	90.0%	90.0%

Sharing Factors

	Zone 1	Zone 2
Aerial (Poles)	50.0%	50.0%
Underground (Conduit)	100.0%	100.0%
Buried (Trenches)	100.0%	100.0%

Calling Volume

Input the number of calls per month, and the average duration.

	Monthly Calls	Minutes Per Call
Local		
Per Residence Line	185	4.00
Per Business Single Line	575	2.50
Per Business Line (Multiline)	800	2.50
Switched Access/Toll		
Per Residence Line	30	3.50
Per Business Single Line	48	3.00
Per Business Line (Multiline)	80	3.00